EXHIBIT D TO EUGENE KILLIAN JR.'S DECLARATION

COST ESTIMATE BASED ON CURRENT CODES & STANDARDS

Formosa Plastics Corp

PVC-Plant Rebuild

Illiopolis, Illinois

November 9, 2005

ABB Project NO. 15091

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1.0 OVERALL SUMMARY

ABB reviewed the current codes and standards requirements for the PVC Project to rebuild the damaged area at the Illiopolis present site. A plot plan and equipment arrangement drawings are developed to meet the present codes and standards. The requirements included, but not limited to, the process and environmental safety, precise process controls and safety shutdown systems, adequate spacing between equipment for the operation and maintenance, and process structures and support buildings design.

The process and environmental safety include the equipment design, venting and drainage systems to eliminate hydrocarbon release using Best Available Technology (BAT) procedures and equipment. The waste treatment and disposal systems are also reviewed and comments are included to meet the present codes requirements. The process control system philosophies for normal operation and safety shutdown for the upset conditions are developed and the design cost is included in the estimate. Adequate spacing is provided between the equipment to meet the insurance policy requirements for safe operation and maintenance. General Electric Global Asset Protection services (previously known as IRI) and Process Industries Practices Standards (PIPs) are used for equipment spacing requirements. These standards are widely accepted and utilized as a general practice in the petrochemical industry. Based on GE and PIP practices, the engineering building, QC laboratory, process controls, electrical motor controls center, and maintenance buildings are relocated providing minimum safe distance required from the process areas.

The definition and bases for cost estimate for each facility is provided in the Backup Documents Sections. MOD1 and MOD2, which are part of Damage Assessment (DA) Area 2 was used as basis for the detailed preliminary design and have generated the engineering drawings and technical data required for the cost estimate. DA Area 2 is chosen as most of the fire and explosion damage occurred in this area. The overall plot plan and equipment layout are developed for the complete plant, leaving undamaged areas as they are where possible. The attached plot plan provides the details on the overall equipment and building layouts. The preliminary design for the process structure, buildings and piperacks were developed in detail for DA Area 2 to use as a basis for the material take offs and pricing. The pricing structure used for this exercise is similar in nature to an original cost estimate developed for the damaged areas with the same basis and unit prices. A site visit was made to access the damage areas in detail. Working with FPC and WGI, the data were gathered and used as a basis for the estimate.

The cost estimate for other areas is prorated from DA Area 2 based on the damage identified and plot plan layout. The Cost Estimate Summary and Detailed Cost Estimate Data Sections provide the details for each area how the estimate is developed. Overall total minimum installed cost for the upgrade of the plant to meet the present codes and standards is about US $ 13.7 million within - 5% to +15%.

2.0 APPROACH TO COST ESTIMATE

The plot plan and equipment arrangement drawings are developed for the total plant based on the insurance requirements for the petrochemical plants. The General Electric Global Asset Protection services and Process Industries Practices Standards are utilized to meet the insurance requirements. The buildings such as the engineering, lab, electric motor controls center and process controls are relocated away from the process units for safety reasons. The elevation drawings and process structures were developed utilizing the same standards to meet the present codes and standards. The preliminary civil and structural design was completed to provide the main and support steel structures. New and revised pipe racks were identified and extended to the support facilities. The DA Area 2 equipment was utilized for the detailed design and materials take-offs. Other cost areas are affected comparatively little and therefore they are prorated based on the damage assessment reports.

The electrical and instrument power loads were summarized and preliminary design was completed for the electrical equipment sizing and the MCC and process controls buildings layout for the cost estimate. The cable trays and cablings were preliminary sized and materials take-offs were completed based the plot plan layout. The process controls philosophy was developed to support the plant startup, normal operation, and scheduled/emergency safe shutdown. The additional instruments required for the process controls were evaluated and included in the cost estimate. The prices were based on the previous work and took into account I/O counts, DCS and SIS systems.

The mechanical design criteria for major pieces of process equipment were reviewed with the present code requirements, where possible, and the prices were adjusted. A preliminary concept was developed to support the venting, flaring and drainage systems to eliminate the hydrocarbon emissions. The waste treatment and disposal system was also compared with the existing facilities and the prices were adjusted to meet the present standards. The piping take-off was based on the plant layout and equipment arrangement drawings. The existing take-off sheets were marked up and new sketches were developed where necessary to support the cost estimate.

The same pricing structure and prices were used for the materials and labor as previously used. Using the total materials by each discipline and applying the same labor rate to the materials developed the total direct cost for the plant. The construction management and engineering cost including the contingency, escalation and contractors' fees were developed based on the ratio to the overall plant cost previously developed. A 50-hour workweek in the field was also utilized.

3.0 COST ESTIMATE SUMMARY

The cost estimate is developed in detail for DA Area 2, which has the most damage. The equipment layout and process structures were preliminarily sized for MOD1 and MOD2. The materials take-off was completed in detail for these areas and adjusted for overall DA Area 2. The cost estimate was completed in the same format as prepared previously and the difference was derived for DA Area 2 from subtracting the original cost estimate from the revised cost estimate. Based on the DA Area 2, other damaged areas were prorated for the upgrade to meet the present codes and standards requirements. A visit was made to the plant and each area was evaluated further in detail working with FPC and WGI for damage. The cost difference was then developed for each area from the original cost estimate. The cost summary is provided for each area with the description on each specific item so that they can be compared directly with the previous cost estimate for its respective area. The summary provides the direct materials and labor costs for each area with an overall cost estimate summary to include the indirect cost.

4.0 DETAILED COST ESTIMATE DATA

Project	PVC Rebuild	Estimate summary	No	15091
Client	Formosa Plastics Corp	**ABB Lummus Global Americas**	Issue	
Location	Illiopolis, Illinois	***Damaged Areas Over-All Totals***	Date	31-Oct-05
Country	USA		Base cur.	USD

Description	DH/ Subc	pcs	Qty	um	Weight MT	Field Man-hours	Labor Amount	Material Amount	Total Amount
Fired Heaters & Boilers		-		mw		-	-	-	
Heat Exchangers		-		m2		-	-	-	
Towers incl internals		-		m2		-	-	-	
Vessels & Reactors		1		mw		40	1,289	15,000	16,289
Storage Equipment		-				-	-	-	
Mechanical Equipment		-		kw		-	-	-	
Pumps & Compressors		41		m3		840	27,065	52,000	79,065
Material Handling Equipm.		-		m3		-	-	-	
Special Plant items		-		m3		-	-	-	
Packaged Equipment		-		m3		-	-	-	
Special Equipment		-		m3		-	-	-	
Miscellaneous Equipment		3		kw		60	1,933	53,000	54,933
EQUIPMENT		**45**				**940**	**30,287**	**120,000**	**150,287**
Piping		-	-	lf	-	70,630	2,020,427	1,359,450	3,379,877
Steel Structures		-	-	ton	-	14,170	342,332	551,599	893,931
Electrical		-	-	kw	-	30,344	977,645	743,259	1,720,904
Instrumentation		-	-	cv	-	19,574	571,837	777,276	1,349,113
MECHANICAL, E&I						**134,718**	**3,912,240**	**3,431,584**	**7,343,825**
Piling		-	-	ea	-	-		-	
Civil works		-	-	cy	-	11,762	285,410	109,554	394,964
Buildings		-	-		-	-		1,066,332	1,066,332
Insulation		-	-		-	-		-	
Fireproofing		-	-			-		-	
Painting		-	allow			-		11,960	11,960
CIVIL WORKS						**11,762**	**285,410**	**1,187,846**	**1,473,257**
MATERIAL & LABOUR						**147,420**	**4,227,938**	**4,739,431**	**8,967,368**
Construction Indirect								3,171,000	3,171,000
License Costs								-	
Vendor Representation								-	
Spare Parts for commissioning									
Spare Parts for 2 years operation								-	
Pre-commissioning									
Training								-	
Chemicals & Lubricants									
Catalyst								-	
Transportation								189,600	189,600
Miscellaneous								-	
OTHER COSTS								**3,360,600**	**3,360,600**
TOTAL DIRECT COSTS									**12,327,968**
Construction Management	Staff								
Construction Management	Local Hired People								
Field Indirect for Constructin Mgt.									
Home Office Engineering						6,750	439,000	42,000	481,000
SERVICES						**6,750**	**439,000**	**42,000**	**481,000**
						TOTAL COST			**12,808,968**
						Escalation		1.50%	192,100
						TOTAL incl. ESCALATION			**13,001,100**
						Insurances (Builders Risk)			97,500
						Bonds			
						Taxes			
						Currency protection			
						Management fee's			
						Proposal cost			
						COMMERCIAL ITEMS			**97,500**
						Contingency (on cost)			
						Risk Cover (on price)			
						Construction Fee and Eng Fee		5.00%	650,100
						TOTAL MARK-UP			**650,100**
						GRAND TOTAL		**USD**	**13,749,000**

LABOR

Description	Area 1	Area 2	Area 3	Area 4	Area 5	Area 6	Area 7	Area 8	Outside Bldg
Equipment									$30,287
Piping		$1,508,475	$74,461	$305,339	$46,485	$41,507			$44,159
New		$5,478,119	$319,442	$1,190,378	$454,291	$1,134,053			
Old		$3,969,644	$244,981	$885,039	$407,806	$1,092,546			
Steel Structures		$132,196	$106,806	$21,453	$38,316	$3,648			$39,912
New		$396,565	$373,832	$236,079	$421,473	$76,462			
Old		$264,369	$267,026	$214,626	$383,157	$72,814			
Electrical	$10,278	$602,749	$95,722	$92,339	$111,251	$57,865			$7,440
New	$652,946	$4,369,931	$693,896	$1,246,770	$1,270,129	$961,924			
Old	$642,668	$3,767,182	$598,174	$1,154,431	$1,158,878	$904,059			
Instrumentation		$544,960	$17,938	$2,249	$3,915	$2,775			Included
New		$6,600,166	$267,105	$85,451	$149,021	$311,101			
Old		$6,055,206	$249,167	$83,202	$145,106	$308,326			
Civil Works		$95,776	$120,429	$28,657	$29,021	$2,790			$589,475
New		$308,608	$454,928	$347,141	$351,460	$64,667			
Old		$212,832	$334,499	$318,484	$322,439	$61,877			

MATERIAL

Description	Area 1	Area 2	Area 3	Area 4	Area 5	Area 6	Area 7	Area 8	Outside Bldg
Equipment									$120,000
Piping		$887,634	$81,506	$19,325	$96,425	$27,987			$246,573
New		$7,701,490	$512,654	$351,733	$1,626,469	$2,045,410			
Old		$6,813,856	$431,148	$332,408	$1,530,044	$2,017,423			
Steel Structures		$292,262	$24,969	$50,852	$88,419	$8,367			$86,730
New		$901,141	$675,202	$580,561	$1,009,454	$182,677			
Old		$608,879	$650,233	$529,709	$921,035	$174,310			
Electrical	$7,893	$454,816	$74,879	$62,962	$74,404	$38,305			$30,000
New	$501,193	$3,297,416	$542,873	$849,986	$849,441	$636,819			
Old	$493,300	$2,842,600	$467,994	$787,024	$775,037	$598,514			
Instrumentation		$544,960	$181,083	$10,722	$21,020	$19,491			Included
New		$6,600,166	$2,067,368	$308,558	$604,908	$1,643,700			
Old		$6,055,206	$1,886,285	$297,836	$583,888	$1,624,209			
Civil Works		$39,467	$49,626	$11,813	$11,959	$1,148			$493,095
New		$127,172	$187,476	$143,063	$144,839	$26,648			
Old		$87,705	$137,850	$131,250	$132,880	$25,500			

TOTAL

Description	Area 1	Area 2	Area 3	Area 4	Area 5	Area 6	Area 7	Area 8	Outside Bldg
Piping									$150,287
Piping		$2,396,109	$155,967	$324,664	$142,910	$69,494			$290,732
New		$13,179,609	$832,096	$1,542,111	$2,080,760	$3,179,463			
Old		$10,783,500	$676,129	$1,217,447	$1,937,850	$3,109,969			
Steel Structures		$424,458	$131,775	$72,305	$126,735	$12,015			$126,642
New		$1,297,706	$1,049,034	$816,640	$1,430,927	$259,139			
Old		$873,248	$917,259	$744,335	$1,304,192	$247,124			
Electrical	$18,171	$1,057,565	$170,601	$155,301	$185,655	$96,170			$37,440
New	$1,154,139	$7,667,347	$1,236,769	$2,096,756	$2,119,570	$1,598,743			
Old	$1,135,968	$6,609,782	$1,066,168	$1,941,455	$1,933,915	$1,502,573			
Instrumentation		$1,089,920	$199,021	$12,971	$24,935	$22,266			Included
New		$13,200,332	$2,334,473	$394,009	$753,929	$1,954,801			
Old		$12,110,412	$2,135,452	$381,038	$728,994	$1,932,535			
Civil Works		$135,243	$170,055	$40,470	$40,980	$3,938			$1,082,570
New		$435,780	$642,404	$490,204	$496,299	$91,315			
Old		$300,537	$472,349	$449,734	$455,319	$87,377			
TOTAL	$18,171	$5,103,296	$827,419	$605,712	$521,215	$203,884			$1,687,671

$8,967,367

FORMOSA PLASTICS CORP.

CODE UPGRADES

Discipline: **Est. Date:** 27-Oct-05

Facility: Formosa Plant, Illiopolis, Illinois **Outside the Building**

Activity or Item Description	Quantities		Labor Estimate				Material & S/C Estimate			Total
	Quantity MTO	Units	Manhoursper Unit	Manhours	Labor Rate $/MH	Total Labor Dollars	Material Unit Rate	Material Cost	S/C Estimate	US Dollars (2005)
BUILDINGS										
Eng'r Building	2,460	s.f.	3.06	7,538	$24.23	$182,646	$60.75	$149,445		$332,091
QC Lab	2,460	s.f.	3.06	7,538	$25.23	$190,184	$67.50	$166,050		$356,234
Control Rm / MCC	1,890	s.f.	4.54	8,581	$24.23	$207,908	$90.00	$170,100		$378,008
CLOSED DRAIN TO NEW SUMP										
Sump Tank 6'Ø x 15' T/T	1	each	40.00	40	$32.22	$1,289	$15,000.00	$15,000		$16,289
Pumps	1	each		40	$32.22	$1,289	$12,000.00	$12,000		$13,289
Pipe - 3" Sch 40, C.S.	200	ft.	2.00	400	$28.61	$11,444	$35.00	$7,000		$18,444
I & E for above	1	Lot		80	$31.00	$2,480		$10,000		$12,480
HC VENT TO INCINERATOR										
12"Ø Sch 10S C.S. Ductwork	150	ft	2.00	300	$28.61	$8,583		$36,417		$45,000
18"Ø Sch 10S C.S. Ductwork	150	ft	2.25	339	$28.61	$9,684		$50,316		$60,000
Fan	1	each		20	$32.22	$644	$18,000.00	$18,000		$18,644
I & E for above	1	Lot		80	$31.00	$2,480		$10,000		$12,480
VENT from DUSTY AREAS to FILTER										
12"Ø Sch 10S C.S. Ductwork	100	ft	2.00	200	$28.61	$5,722		$24,278		$30,000
18"Ø Sch 10S C.S. Ductwork	100	ft	2.25	225	$28.61	$6,437		$48,563		$55,000
Filter	1	each		20	$32.22	$644	$20,000.00	$20,000		$20,644
Fan	1	each		20	$32.22	$644	$15,000.00	$15,000		$15,644
I & E for above	1	Lot		80	$31.00	$2,480		$10,000		$12,480
MECHANICAL EQUIPMENT UPGRADE										
Pumps	40	each	20.00	800	$32.22	$25,776	$1,000.00	$40,000		$65,776
Firewater (Deluge System)	1	Lot	80	80	$28.61	$2,289	$80,000.00	$80,000		$82,289
STEEL OUTSIDE MOD 1&2 BUILDING										
Steel	41.3	Tons	40	1,652	$24.16	$39,912	$2,100.00	$86,730		$126,642
Concrete	30	cy	12	360	$24.27	$8,737	$250.00	$7,500		$16,237
Sub-total Base Estimate				**28,392**	**$25.05**	**$711,273**		**$976,398**		**$1,687,672**

Allowances & Adjustments										
FACTORS:										
- MTO/Design Allowance %										
- Productivity										

CALCULATED ADJUSTMENTS:										
- MTO/Design Allowance					MHs					
- Productivity					MHs					

Total Adjusted Estimate				**28,392**	**$25.05**	**$711,273**		**$976,398**		**$1,687,672**

5.0 REFERENCE DOCUMENTS

The GE GAP Guidelines (GAP.2.5.2, dated September 2, 2001), Oil and Chemical Plant Layout and Spacing (previously known as IRI) and Process Industry Practices (PIPs), were used as the basis for the new equipment spacing and in preparation of the plot plan shown on the attached arrangement drawing.

6.0 BACKUP DOCUMENTS

6.1 Process/Environmental

The document used to evaluate safety, health and environmental requirements to meet present codes and standards is attached here. Typically, this document identifies applicable codes and standards, and provides information to the client and engineering contractor for plant design and preparation.

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16.0 SAFETY, HEALTH, AND ENVIRONMENT – SAFETY MEMORANDUM

16.1 Objective

It is the practice of ABB Lummus Global to issue a HSE memorandum at the onset of each project. There are several purposes for issuing such a memorandum; these are:

1. The memorandum addresses three areas of concerns, Health, Process Safety, and Environmental. The memorandum will list all the client's standards, national and international codes. Additional safety features implemented by ABB Lummus Global such as exceptions to client standard design practices and industry recommended practices (API RP 520/521) are addressed.

2. Inform the client or third engineering party of the basic and/or detailed safety features that are incorporated in the documents issued for the projects. These documents could include Process Flow Diagrams and Piping & Instrument Diagrams (at any milestone), equipment and instrument data sheets, project specifications, Plot Plans, Electrical Area Classifications, Fire and Gas Detection and Protection, etc.

3. Inform all engineering disciplines of the hazards associated with the process. The memorandum will outline the protective and mitigating measures that the engineering disciplines will incorporate in the design. Features such as emergency isolation, Safety Instrumented Systems (SIS) and associated Safety Integrity Levels (SIL), fireproofing, etc.

4. Inform clients and internal engineering disciplines of any additional safety studies that will be required to comply with both ABB Lummus Global's procedures and contractual requirements.

16.2 Input

Input to the preparation of the Safety Memorandum are listed as follows:

- Process Flow Diagrams
- Heat and Material Balances
- List of Hazardous Materials in the Process
- Preliminary Safety Reviews (if already conducted)
- Equipment Data Sheets
- Conceptual design of environmental systems, such as gaseous, liquid, and solids effluents and means of treatment and disposal
- Conceptual of the basic and safety interlock systems

16.3 Typical Safety Memorandum

Attached is a typical Health, Safety, and Environmental Memorandum that could be used as a template for projects. The contents will very depending on the scope and complexity of the project. In certain situations, and particularly when basic engineering packages are prepared by a third party or licensor, some if not all the safety features could have been already incorporated in the provided documents. If upon reviewing these documents and determining that they do not comply with the safety features that ABB Lummus Global normally incorporates, it is imperative that the deviations be documented either in a safety memorandum or separate document, and the licensor or third party is informed of this deviations(s). It is also important to advise clients of these issues.

Furthermore, if corrective measures or changes are required to the process and/or to the safety features in order to fully comply with ABB Lummus Global or client requirements, all parties including licensor and clients must approve these changes.

Typical Safety Memorandum/Cause and Effect Document

1.0 Introduction

The safety memorandum outlines the basic HSE design features that will be incorporated in the process and equipment design of the Process Units.

The governing codes applicable to the Process Units are listed in the Basic Engineering Design Data and will be attached with this document for reference.

The following sections describe briefly the contents of the Safety Memorandum, which will be developed for the project.

2.0 Health Considerations

Material Safety Data

Material safety data including physical and chemical properties related to health and safety for process materials relevant to the processes will be presented in this document. Permitted worker exposure limits based on US Occupational Safety and Health Administration (OSHA) federal regulations are also provided for regulated substances.

Control of Chronic Health Effects

Long-term exposure to hazardous substances such as benzene can increase the risk of contracting specific types of cancer. Maintaining the permissible exposure limit of benzene in the workplace also requires control of fugitive emissions. To control emissions of these substances such as benzene, Lummus Global's design endeavors to avoid continuous or intermittent benzene venting to the atmosphere.

Chemical Hazards

The intrinsic chemical associated with the Process Units is due to the presence of highly combustible hydrocarbons and streams containing hydrogen sulfide and benzene. The chemical properties, toxicology, disaster hazard, precautions, respiratory equipment, first aid requirements associated with handling hydrogen sulfide are addressed in the document.

Noise Abatement

This specific process does not present any unique or technology specific noise problems. Typical noise sources include rotating equipment, air coolers, heater burners, fluid flow throttling devices (i.e., control valve stations), and steam jet ejectors.

3.0 Process Safety Considerations

Safety Design Requirements

In the design of the Process Units, USA industrial codes standards and generally accepted recommended practices regarding process safety will be followed to supplement client's own standards. Specific requirements provided by the client for process safety will be incorporated in the design. The major codes, standards, and recommended practices that will be followed are outlined below along with any specific exceptions that have been taken.

ASME Boiler and Pressure Vessel Code

API Recommended Practices and Standards - Lummus Global generally follows the recommended practices and standards of the American Petroleum Institute (API) with respect to overpressure protection of process equipment given in the following publications:

- Recommended Practice 520, Sizing, Selection and Installation of Pressure-Relieving Devices in Refineries (Latest Edition).
- Recommended Practice 521, Guide for Pressure-Relieving and Depressuring Systems (Latest Edition).
- Standard 2000, Venting Atmospheric and Low Pressure Storage (Latest Edition)

Exceptions to these recommended practices and standards are tube rupture in shell and tube heat exchangers and the use of the procedures developed by the Design Institute for Emergency Relief Systems (DIERS) for multi-phase emergency relief. The methods sanctioned by DIERS should be used to design emergency relief and flare systems for multi-phase flow as appropriate.

3.1 Flare and Relief Mitigation Systems

Refinery Units Emergency Relief Data

Generally the development of individual relief rates is based on the guidelines provided in API RP 521. The emergency relief data will be developed for major emergency relief events including plant-wide loss of supporting utilities such as electrical power and boiler feed water.

Causes of Overpressure

The electrical power or cooling water outages results in the activation of a number of safety relief devices in the Process Units. For the development of the total Process Units relief rate, it is assumed that these individual discharges occur concurrently.

Offsite Flare System Design Considerations

Design Basis Relief Rates

The design basis relief rate should be developed by means of a thorough response analysis all process units to site-wide common failure modes.

Typical US industry practice is to design for the largest relief resulting from any one common failure mode. Usually a total site-wide outage of a major utility system such as cooling water or electrical power determines the maximum relief rate. Utility systems need to be carefully analyzed to determine if they are indeed independent. Otherwise the simultaneous failure of interdependent utility systems may be a credible worst case.

4.0 Environmental Considerations

It is the responsibility of the owner of the Process Units to define the set of environmental performance criteria for detailed engineering design of the facility. These standards include but are not limited to:

- Fugitive emission control strategy
- Underground storage tank system design
- Wastewater collection and treatment

4.1 Gaseous Effluents

Design Basis

Gaseous effluents from the Process Units are controlled to meet the requirements of New Source Performance Standards, 40 CFR 60 - Standards of Performance for Volatile Organic Compound Emissions from Synthetic Organic Chemical Manufacturing Industry Distillation Operations.

Vent Gas

Inert compounds present in the HYDROCARBON OR CHEMICALS feed will pass overhead and will be removed as non-condensable typically from an overhead drum. This gas is routed to the fuel gas header for use within the complex. In case of high pressure in the overhead drum, the gas will be routed to the flare.

4.2 Aqueous Effluents

Process Wastewater

Process sour and wastewater from the Process Units will be contaminated with hydrocarbons. All process wastewater is routed to Wastewater Treatment (OSBL).

Non-Process Wastewater

Aqueous waste streams will be produced from Process Units operations. Non-process wastewater will include maintenance and washdown water, blowdown from steam generators, cooling tower blowdown and storm water run-off.

5.0 Controls Concept

The control systems concepts are defined on P&IDs. These control functions will be accomplished in one of three types of systems. The Distribution Control System (DCS), a redundant Programmable Logic Controller (PLC), or local control panels supplied by package vendor.

The DCS will accomplish all control functions required by operations, from the existing Central Control Room. These functions shall include, process monitoring and alarming, analog control loops, equipment system status monitoring, and graphic displays.

A PLC will be used for all interlocking and shutdown logic requirements. It will be linked to the DCS via data highway, for monitoring and displaying purposes.

- Digital field contacts shall be closed while in the normal operating conditions, (open to alarm).
- Solenoid valves shall be energized while in normal operation, (de-energize to trip).

Package vendors may be required to supply a local control their equipment. A vendor supplied PLC may be required for some systems. System status signals may be required for alarm indication in the DCS.

5.1 Gas Detecting System

Types of Gas Detectors

There are various types of gas detectors used in petrochemical plants. Most plants will have:

- An explosion meter, to monitor amounts of flammable or explosive gas/air mixtures resulting from leaks or other releases.
- An oxygen analyzer, used mainly to monitor oxygen levels when purging equipment.
- A type of chemical gas detector for detecting and identifying chemical gases. One of the most commonly used detectors of this type works on a color change of crystals sensitive to the gas to be analyzed.

Gas Detectors Installations

- Flammable gas sensors shall be installed at minimum following locations where the leaking gas or vapor is likely to accumulate:
- Air intake of the Satellite Rack Room/MCC building
- Analyzer houses
- The area which may be accumulated in accidentally dispersed flammable gas
- Toxic gas sensors for H_2S shall be located in close proximity to the potential location of a leak

5.2 Shutdown Valves

Pneumatically or electronically operated valves equipped with a solenoid valve and a proximity sensor shall be used for shutdown valves in principle.

- All valves shall be of air-to-fail-to-safe-position and power-to-fail-to-safe-position type.
- The valve position (open or close) shall be displayed on DCS CDT by using a proximity sensor so that operator can confirm that shutdown valves are successfully operated by interlocking system.
- Fail position at valves shall be indicated by paint color

5.3 Heater Safeguarding

This section describes the principles of the safeguarding of the Process Unit heaters. Note that all the safeguarding instrumentation should be separate from the control instrumentation.

The following are typical trip initiators, some of which may be already installed or require addition:

- Emergency Switch
- Low-low Heater Feed Flow
- High-high Combustion Pressure
- Low-low Combustion Air Flow
- High-high Fuel Gas K.O. Drum Level
- High-high Fuel Gas Pressure
- High-high Fuel Oil Pressure
- High-high Pilot Gas Pressure
- Low-low Fuel Gas Pressure
- Low-low Fuel Oil Pressure
- Low-low Pilot Gas Pressure
- Emergency Steam-out Switches
- Low Atomizing Steam/Fuel Oil Differential Pressure
- Damper Minimum Stops
- High-High Heater Outlet Temperature
- Induced and Forced Draft Fans Low Speed
- Pilot Burner Flame Detector
- Air/Fuel Ratio

5.4 Gas Compressor Safeguard

Compressors will be provided with an interlock shutdown system, which conceptually is activated from following features:

- Local emergency shutdown hand switch (each compressor)
- Remote (from control room) emergency motor trip
- High-high liquid level trip from Fractionator Overhead Gas K. O. Drum first stage suction)
- High-high liquid level trip (interstage KO Drum)
- High-high compressor discharge temperature (each stage)
- Low-low compressor suction pressure (each stage)
- Low-low lube oil pressure (to be confirmed)

It is recommended that a common dedicated alarm be provided for the shutdown system.

6.0 Fire Protection

Fire protection for the Process Units is provided according to the applicable NFPA Codes and LOCAL Standards.

7.0 Area Classification

7.1 Extent of Hazardous Area

The extent of hazardous area shall be as laid down in the CLIENT or LOCAL document.

A section of this document may contain hazardous area which include the following major facilities:

- Plants, Equipment Process Vessels
- Enclosed premises with purging system. Air intake of the fresh air purge system not less than 1.5 meters above the hazardous area (any division)
- Enclosed premises without purging system
- Pipelines with well maintained valves, meters, fittings
- Tanks above ground (floating roof)
- Tanks above ground (cone roof)
- Pumps withdrawal fittings

7.2 Specific Area Classification Considerations

- Fired Heater
- Control Building

8.0 Layout Considerations

Guidelines for plant layout for the Process Units are detailed in either CLIENT document or use of Lummus Global's design criteria. This document defines minimum layout requirements within the plant boundary for petroleum refineries, oil/gas production and processing plants.

The document addresses layout of process units with specifically related to the following:

- Location of unit piperack
- Grouping of exchangers and vessels
- Spacing between battery limits of individual pieces of equipment
- Spacing between two process units and the requirements for shutdown coordinations of units
- Relative locations of air fan coolers to pumps handling hydrocarbons and materials above the temperature of 230oC
- Location of fractionation columns

- Upwind location of heaters and provisions of spacing for heater auxiliary equipment and maintenance purposes
- Location of control room and electrical substation

9.0 Metallurgical Considerations

CLIENT or ABB LGI documents may provide a comprehensive guidelines for the selection of materials of construction for equipment and piping in the Process Units. The document may discuss the type of corrosion and stress cracking expected in the Process Units as sulfur corrosion, sour water corrosion that results in Sulfide Stress Cracking and Hydrogen Induced Cracking (HIC), and Amine Stress Cracking.

The document may also includes the following sections:

Equipment Summary and Material List

- Heaters
- Fractionating Equipment
- Shell and Tube Exchangers
- Air Coolers
- Vessels and Drums
- Flame Arrestor
- Pumps
- Exchangers

10.0 Special Operating Precautions

It is the responsibility of all personnel to make themselves familiar with the hazardous nature of the materials handled by the unit, the safety precautions and regulations of the unit and the safety equipment available within the unit. Typical operating instructions are provided for the following:

- Opening Lines and Equipment
- Opening Large Vessels
- Fire-Fighting Equipment
- Self-Contained Breathing Apparatus
- Leaks

6.2 Instrument Controls Philosophy

The attached document was developed to provide the minimum safety requirements for Instrumentation and Control for the estimate of the rebuild effort for the PVC plant Rebuild Project. This document is preliminary and can be developed further for the project rebuild, if required.